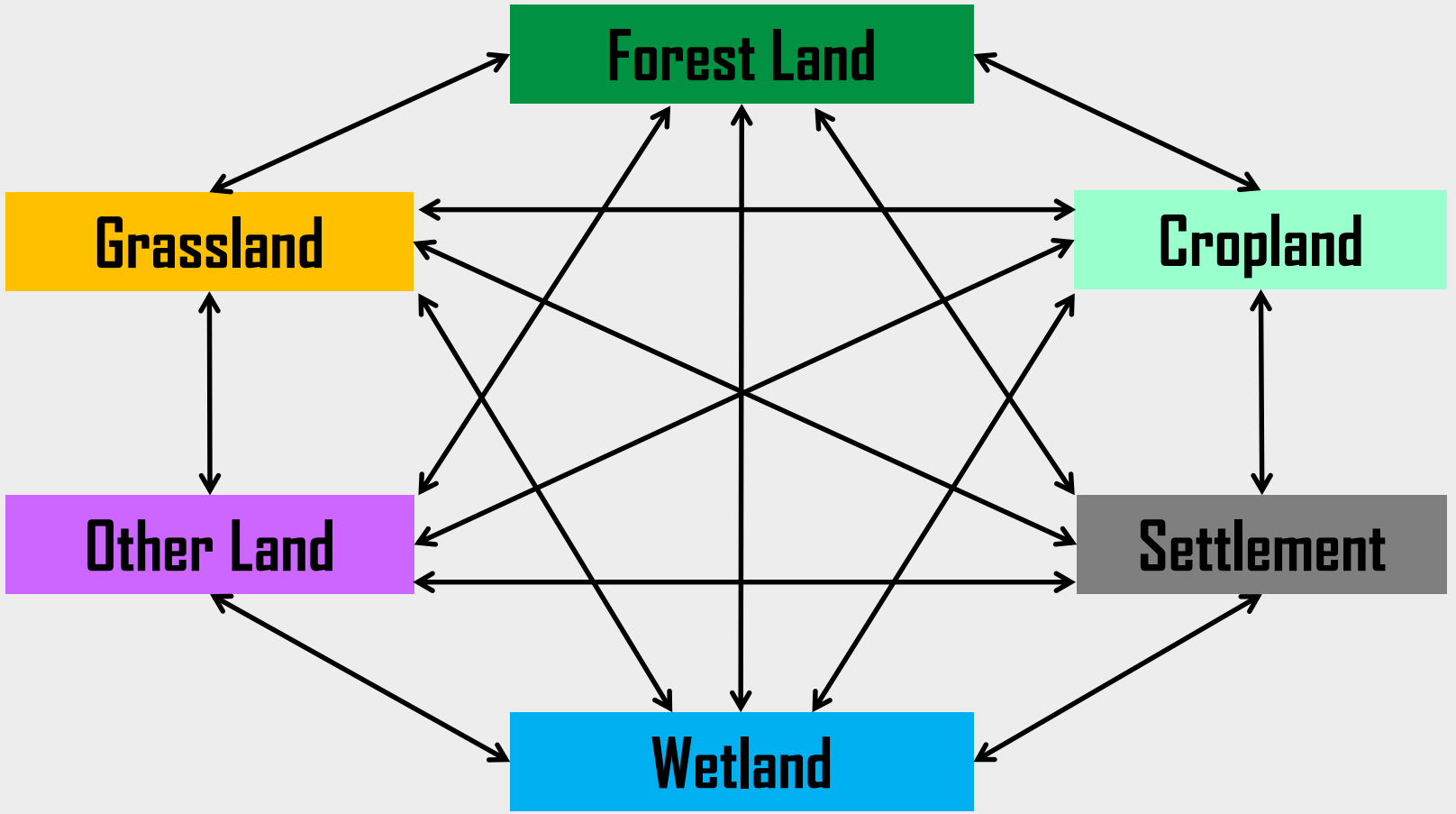

CALIFORNIA
AIR RESOURCES BOARD
Draft
Natural & Working Lands
Inventory
October 23, 2018

Meeting Agenda

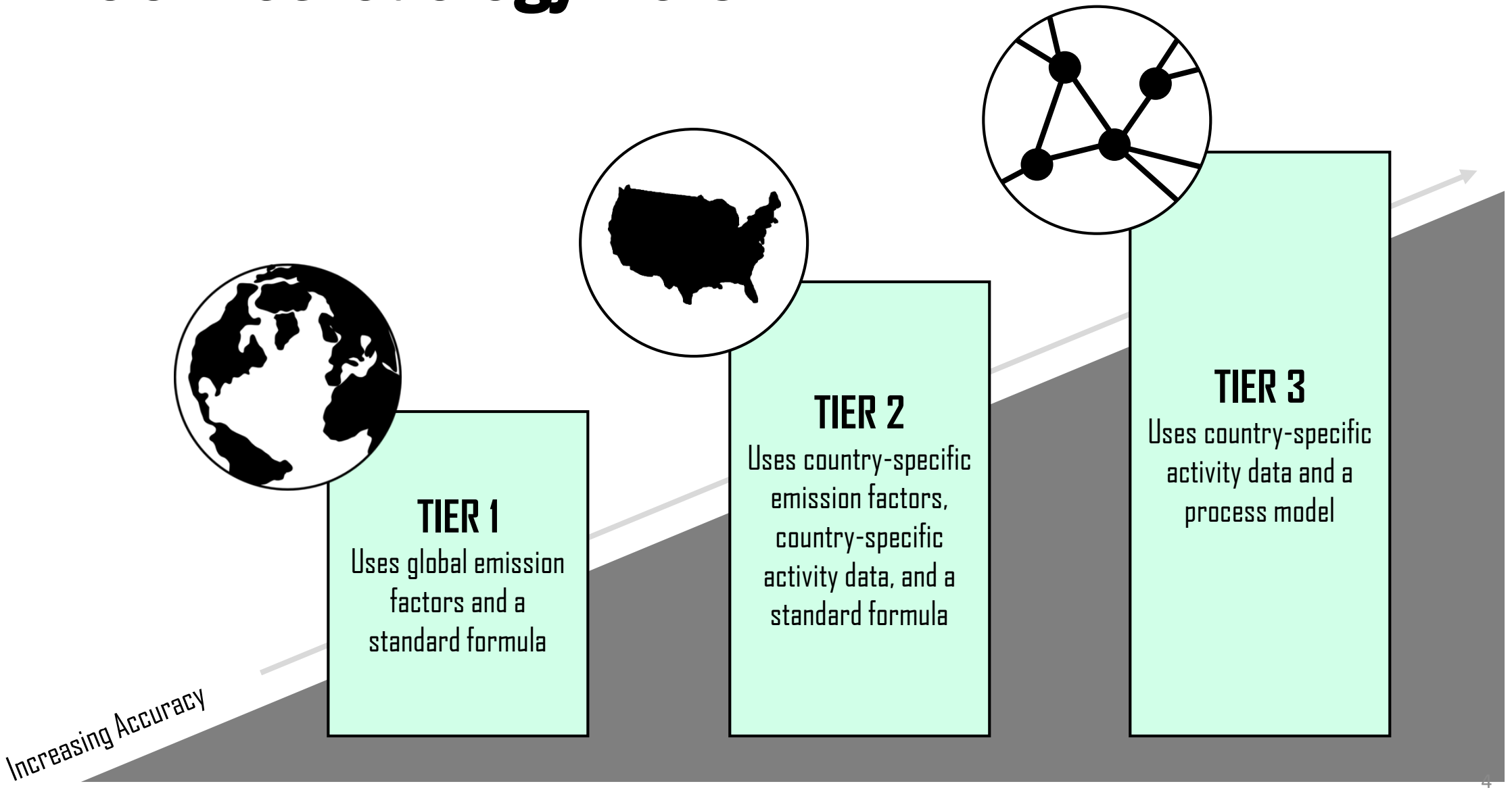
1. Welcome and Introduction
2. NWL Inventory Overview
    - Forests and Other Natural Lands
    - Croplands
    - Urban Lands
    - Soil Carbon
    - Wetlands
3. Upcoming Work
4. Discussion

IPCC Conceptual Framework:

Stasis vs Transition



IPCC Methodology Tiers



Stock Difference Method

Time

100 Mg Carbon
Carbon Stocks, *Time 1*

1000 Mg Carbon
Carbon Stocks, *Time 2*

$$C\ stocks_{Time2} - C\ stocks_{Time1}$$

= 1000 Mg C – 100 Mg C = 900 Mg C

Forests & Other Natural Lands Inventory

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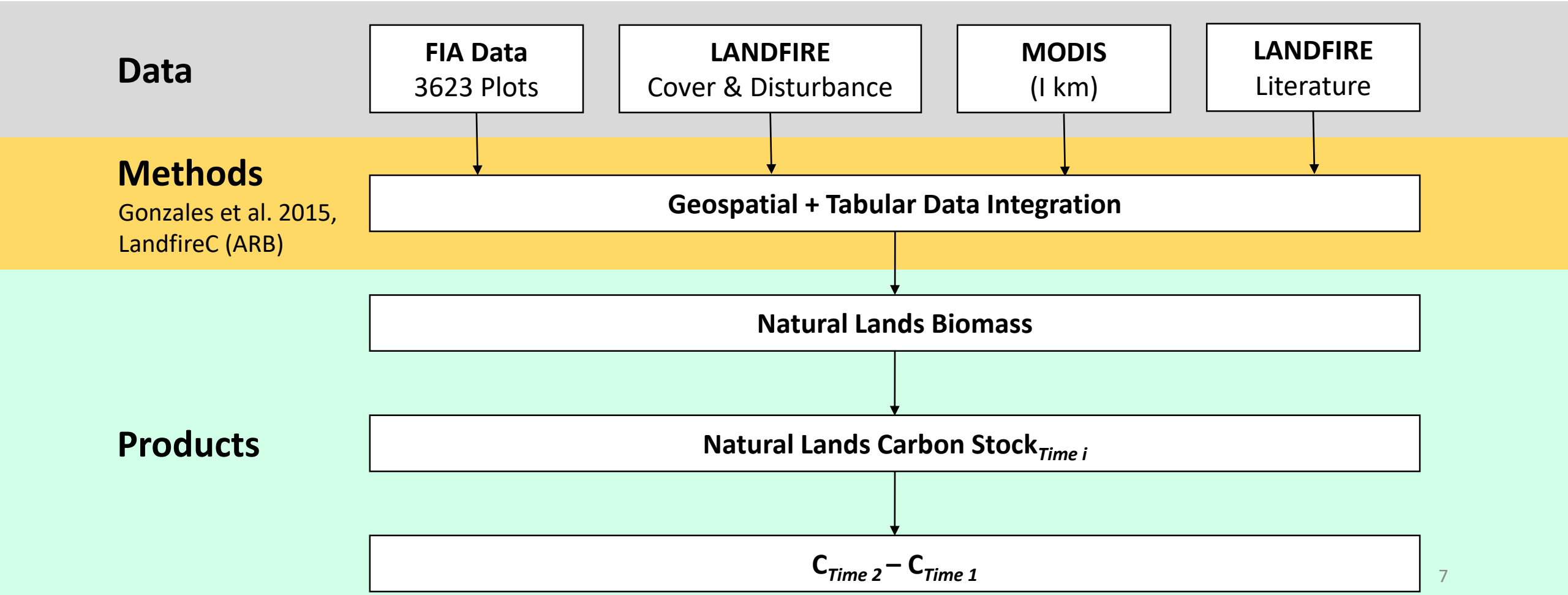
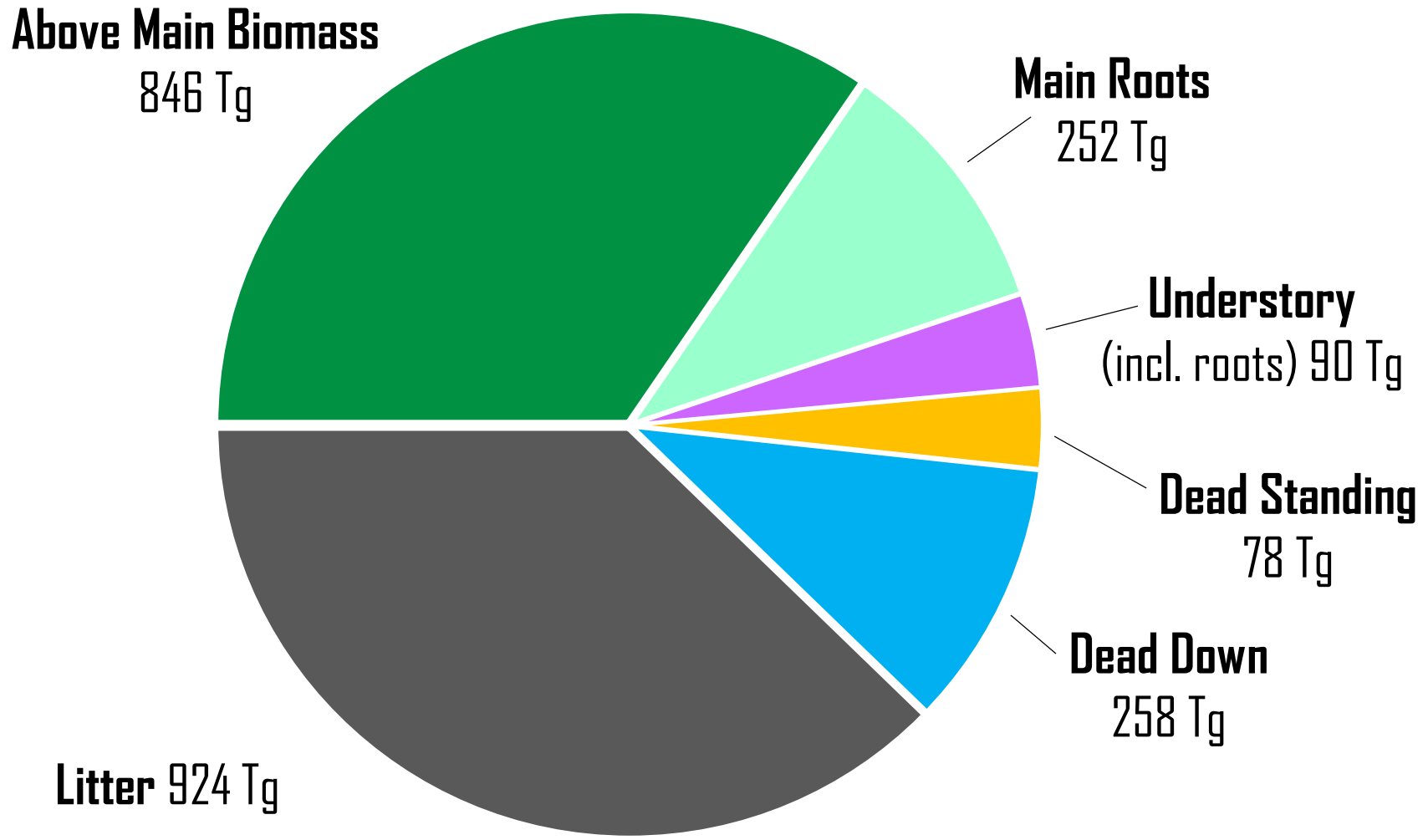
Forest and Other Lands Inventory Data & Methods Overview



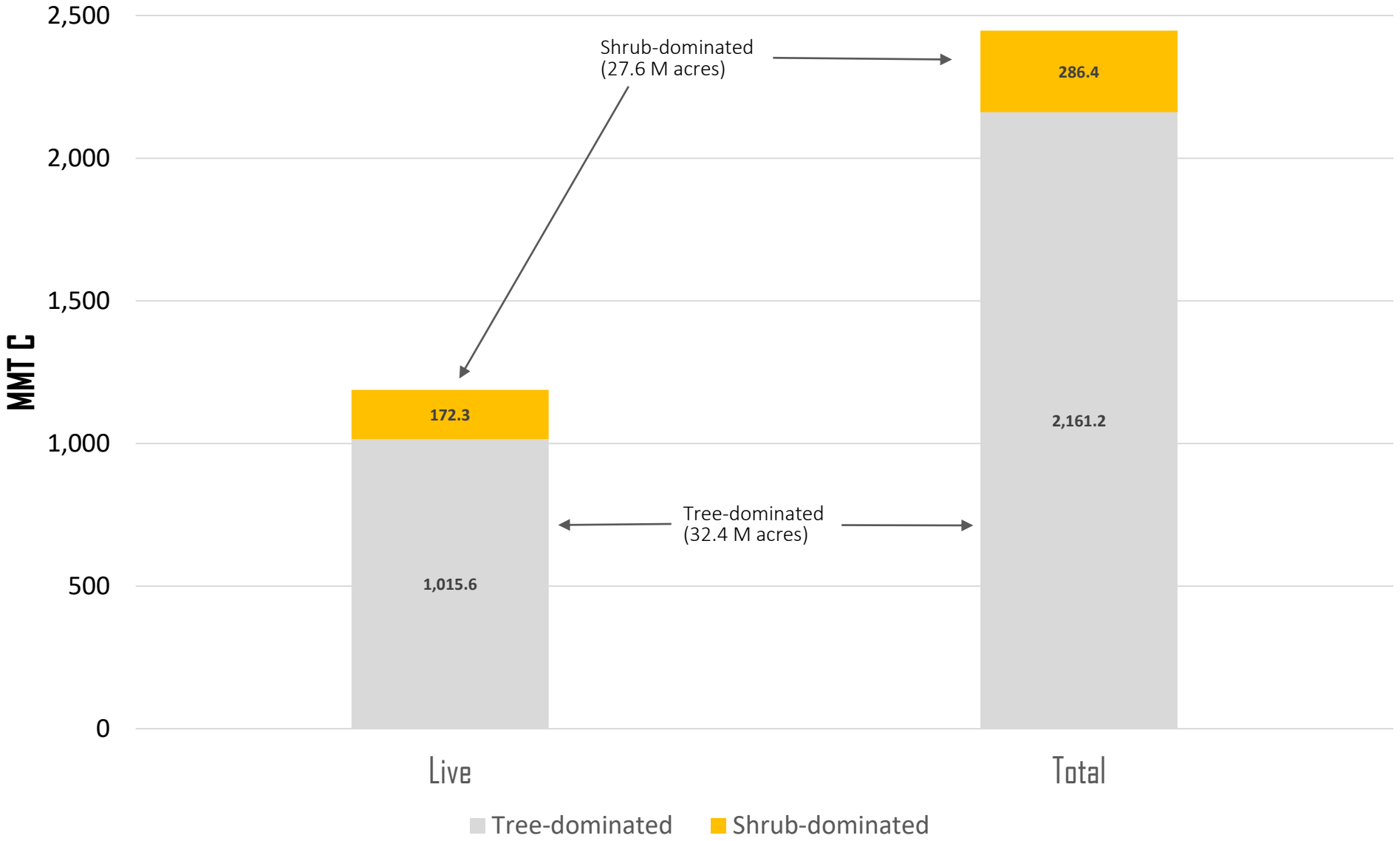
Forest Land Carbon Pools

2,448 Total Tg C



Tree & Shrub Dominated Forest Land

Live & Total Biomass Carbon Stocks



Forests & Other Natural Lands 2010 – 2012
Changes in Above-Ground-Live Carbon Stocks (MMT C)

		2012					
	Land Cover	Croplands	Forests	Grasslands	Other Lands	Settlements	Wetlands
2010	Croplands	TBD	TBD	TBD	TBD	TBD	TBD
	Forests	**-0.49**	**11.53**	**-3.67**	**0.23**	**-1.1**	
	Grasslands	**-0.06**	**6.3×10^{-6}**	**-0.3**	**6.0×10^{-4}**	**-0.02**	
	Other Lands	**-0.00**			**0**	**-0.00**	
	Settlements					TBD	
	Wetlands						**0**

Forests & Other Natural Lands 2012 – 2014
Changes in Above-Ground-Live Carbon Stocks (MMT C)

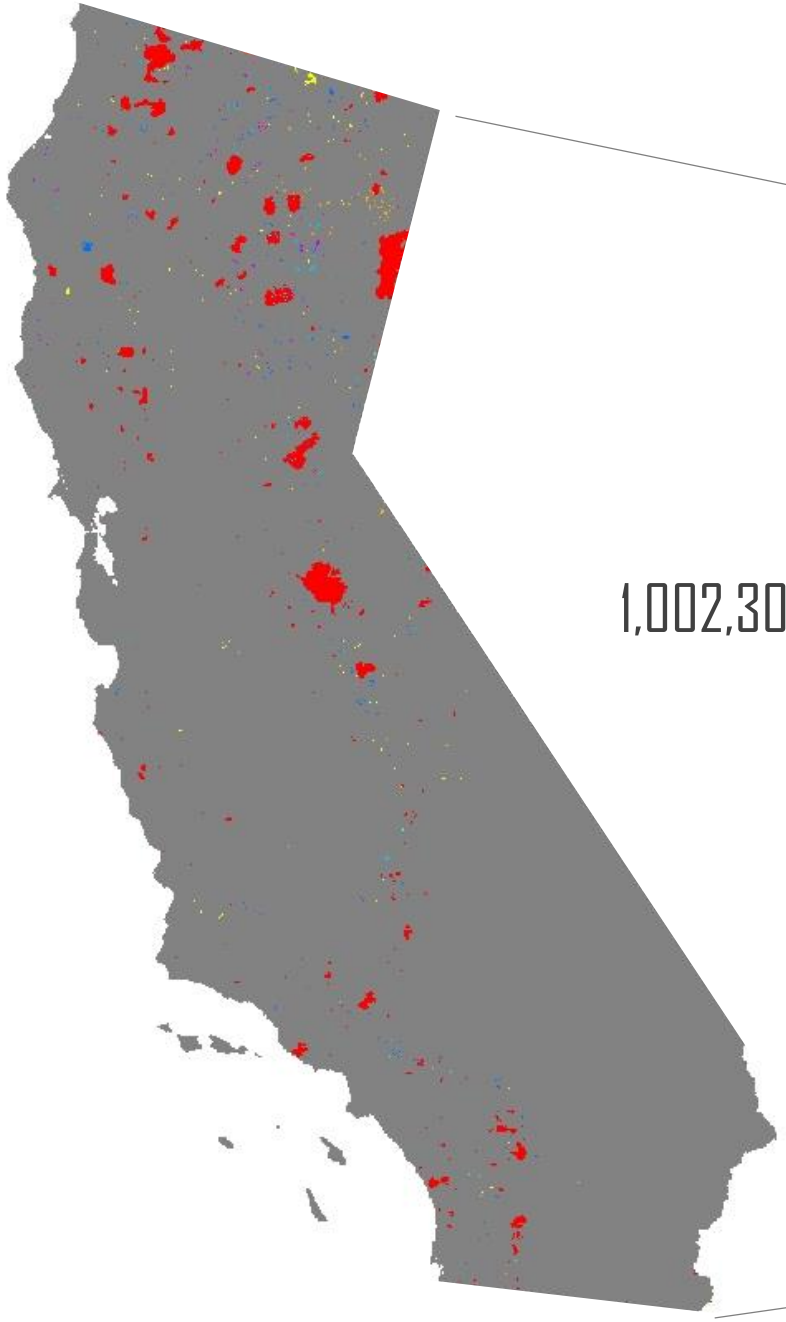
		2014					
2012	Land Cover	Croplands	Forests	Grasslands	Other Lands	Settlements	Wetlands
	Croplands	TBD	TBD	TBD	TBD	TBD	TBD
	Forests		**4.96**	**-6.05**			
	Grasslands		**3.18**				
	Other Lands				**4.14×10^{-7}**		
	Settlements					TBD	
	Wetlands						

Forest and Other Natural Lands 2012 - 2014
Changes in Total* Carbon Stocks (MMT C)

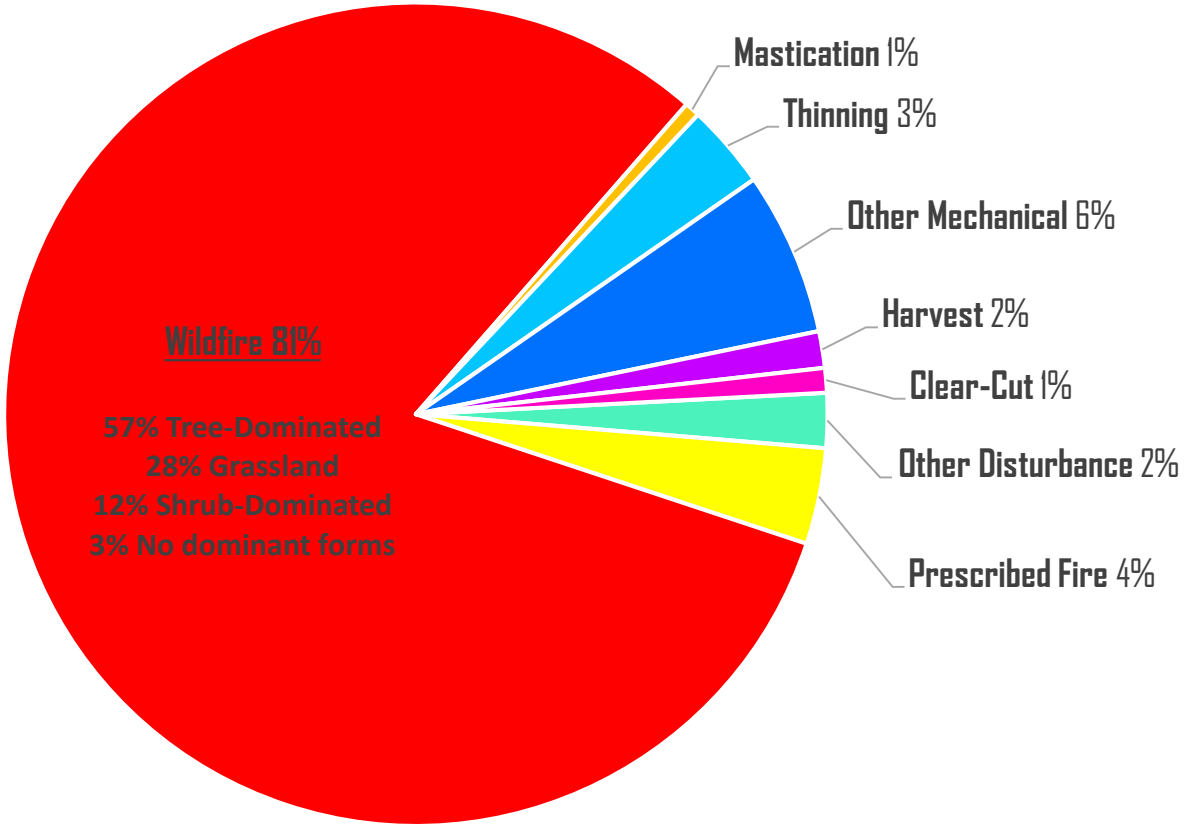
*Live and dead pools, not including soils

		2014					
2012	Land Cover	Croplands	Forests	Grasslands	Other Lands	Settlements	Wetlands
	Croplands						
	Forests		3.63	-15.87			
	Grasslands		27.85	3.96×10^{-3}			
	Other Lands				4.14×10^{-7}		
	Settlements						
	Wetlands						

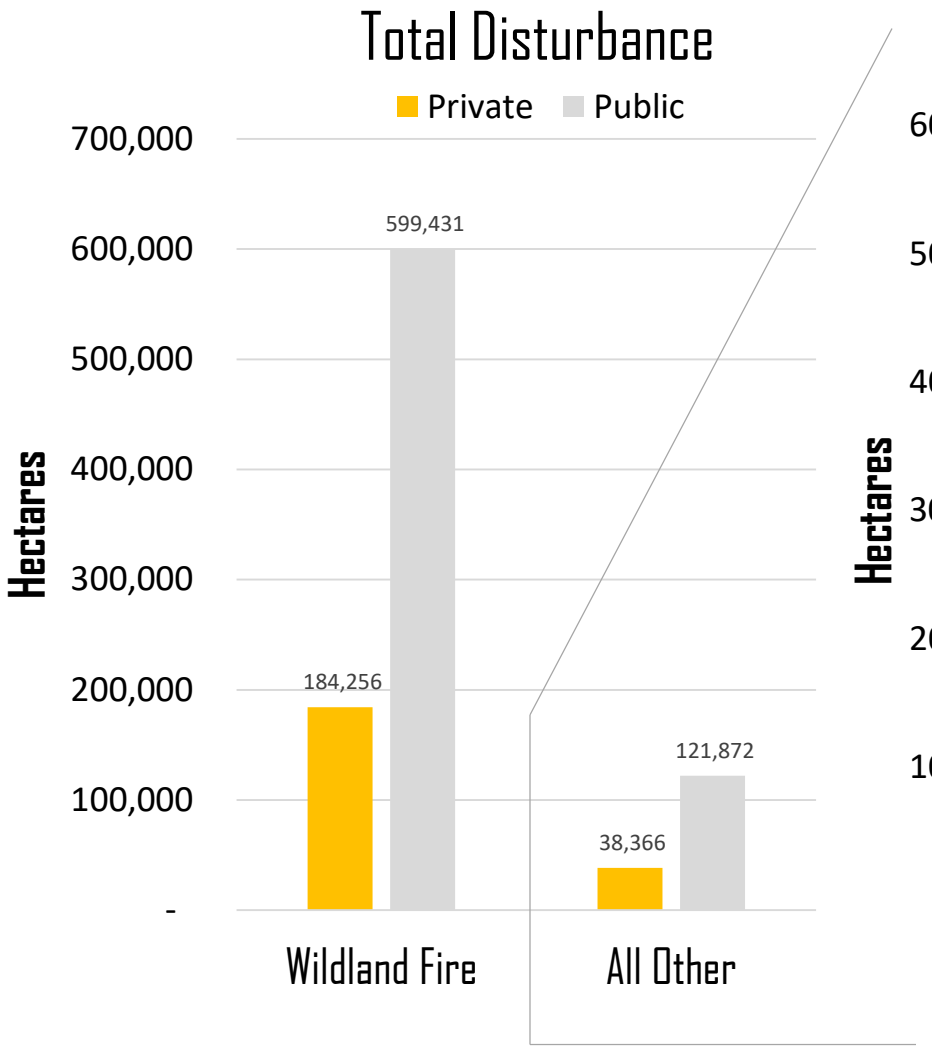
Disturbance 2012 - 2014

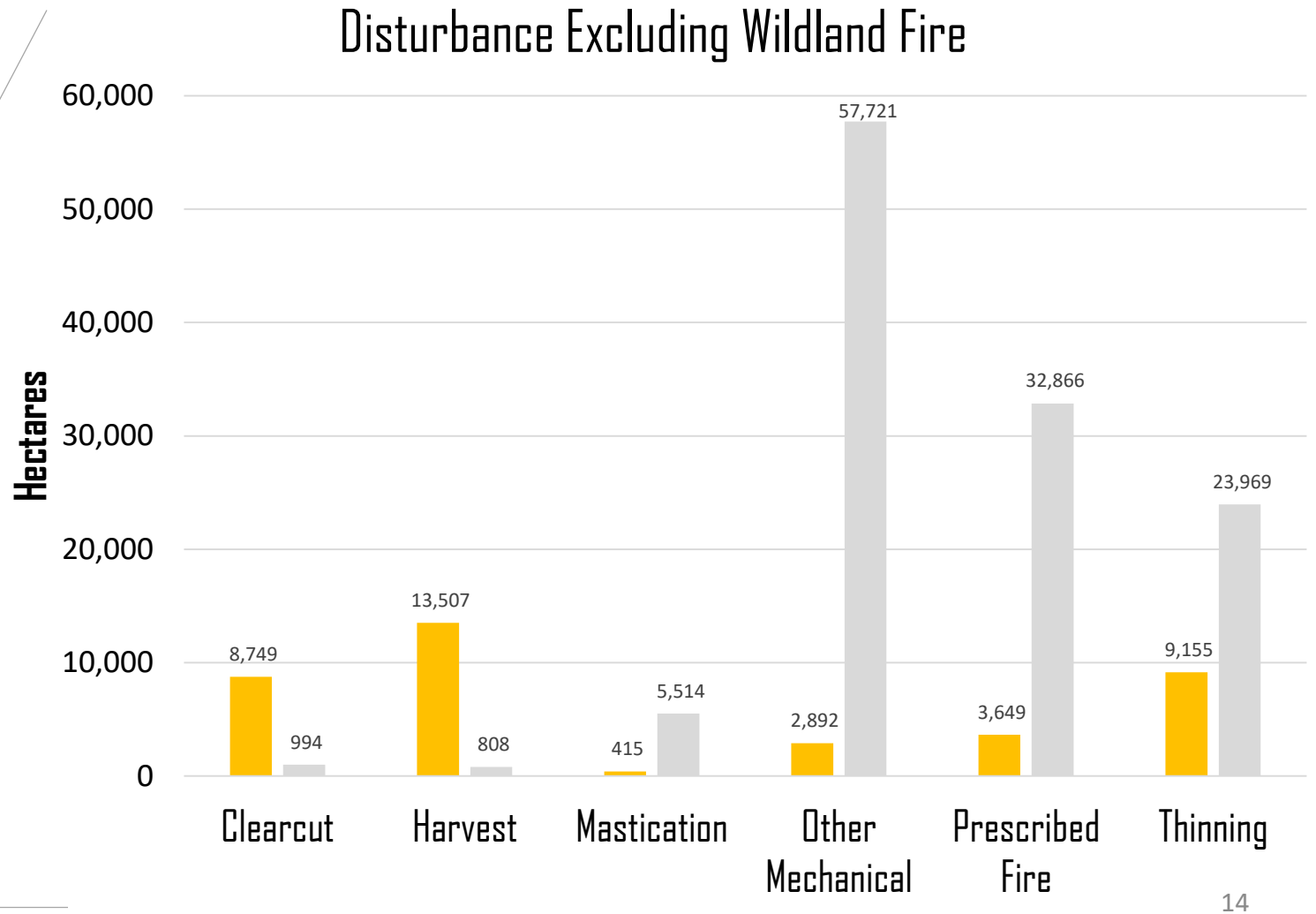


1,002,300 hectares



Disturbance by Ownership 2012 - 2014





QUESTIONS?

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Woody Crop & Urban Forest Inventories

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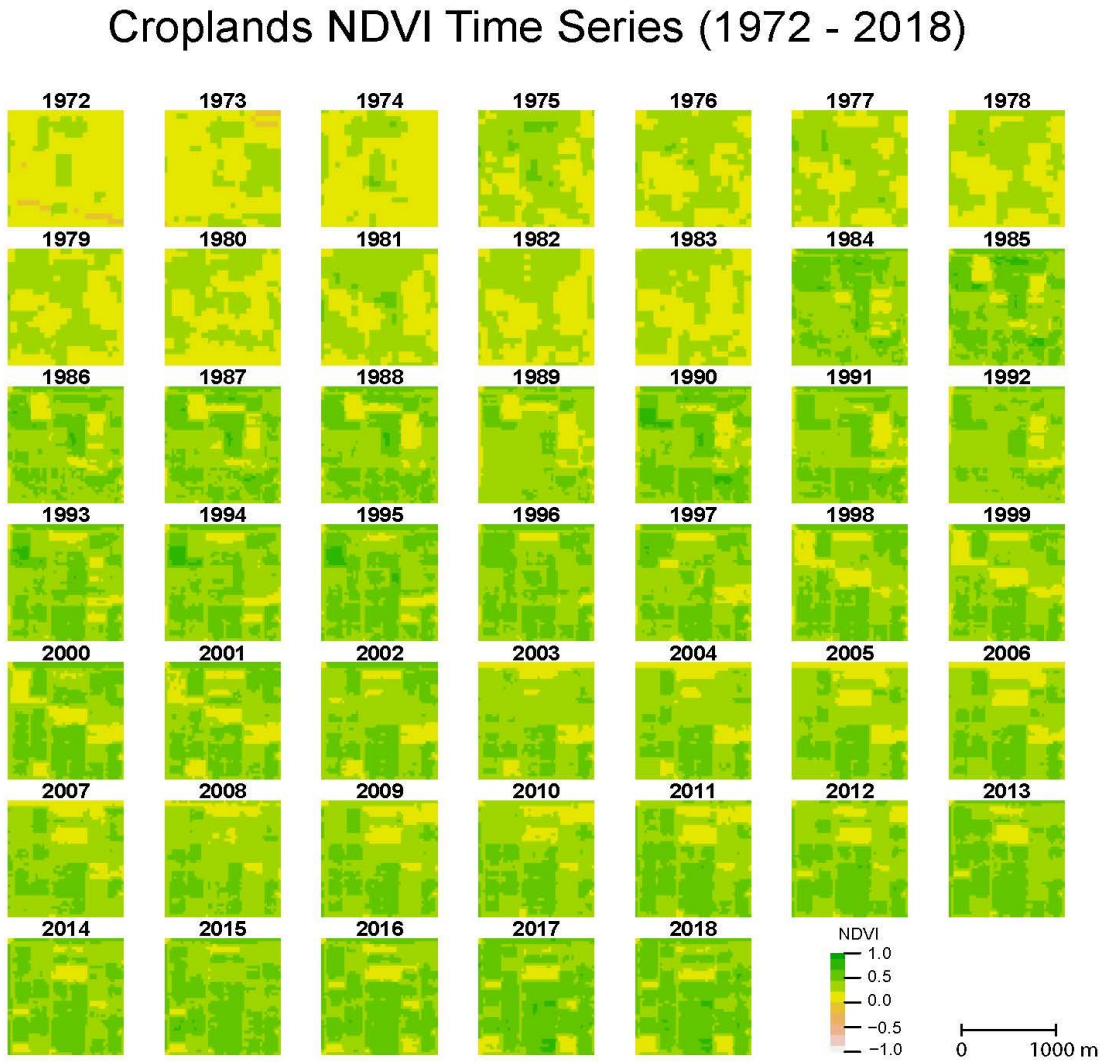
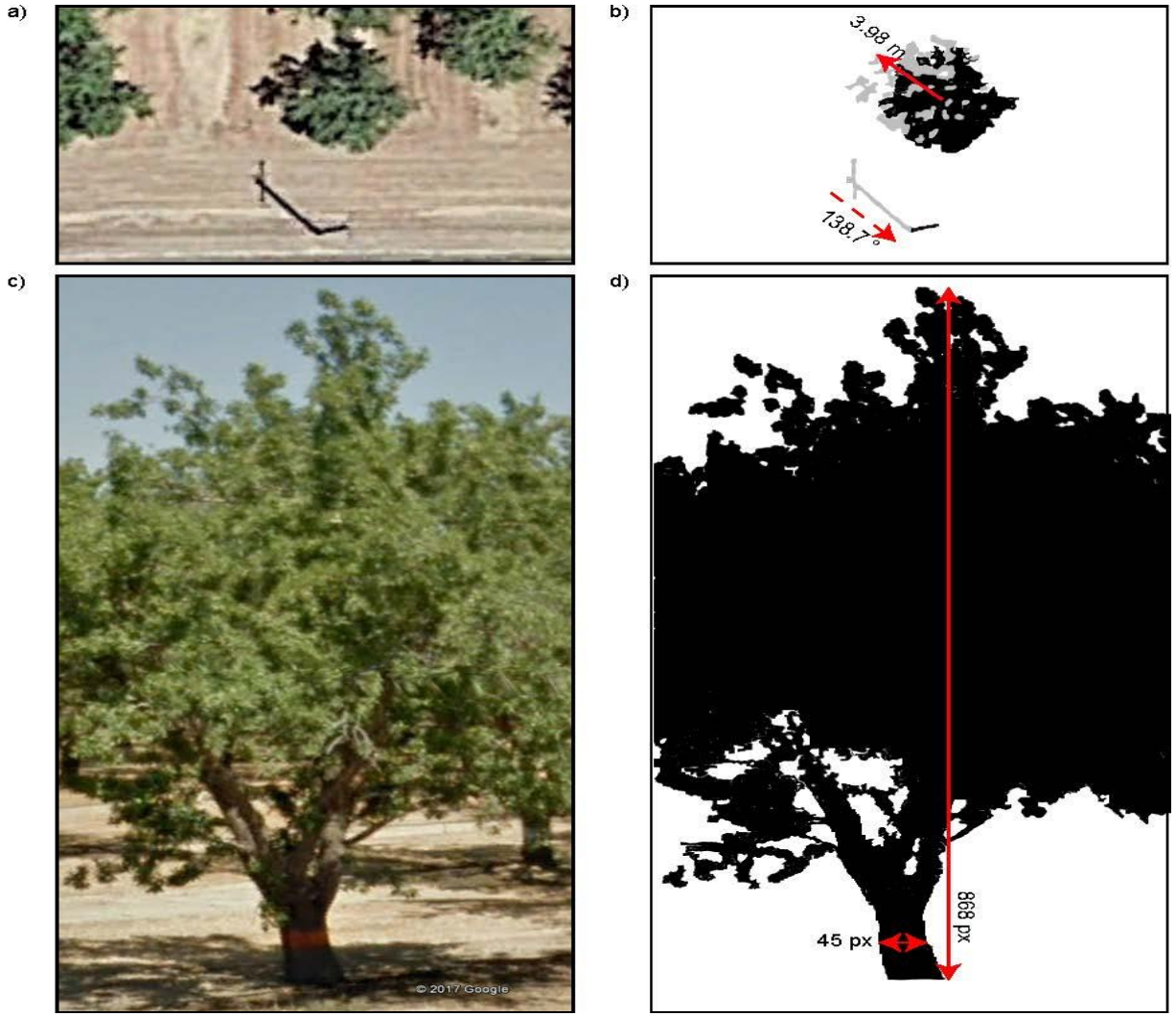
Orchard Carbon Quantification Methods



Map orchard types and ages	Relate height to age/orchard type	Relate height to diameter	Apply allometric equations	Relate tree density to age	Quantify Carbon Content

Orchard Carbon Quantification Methods



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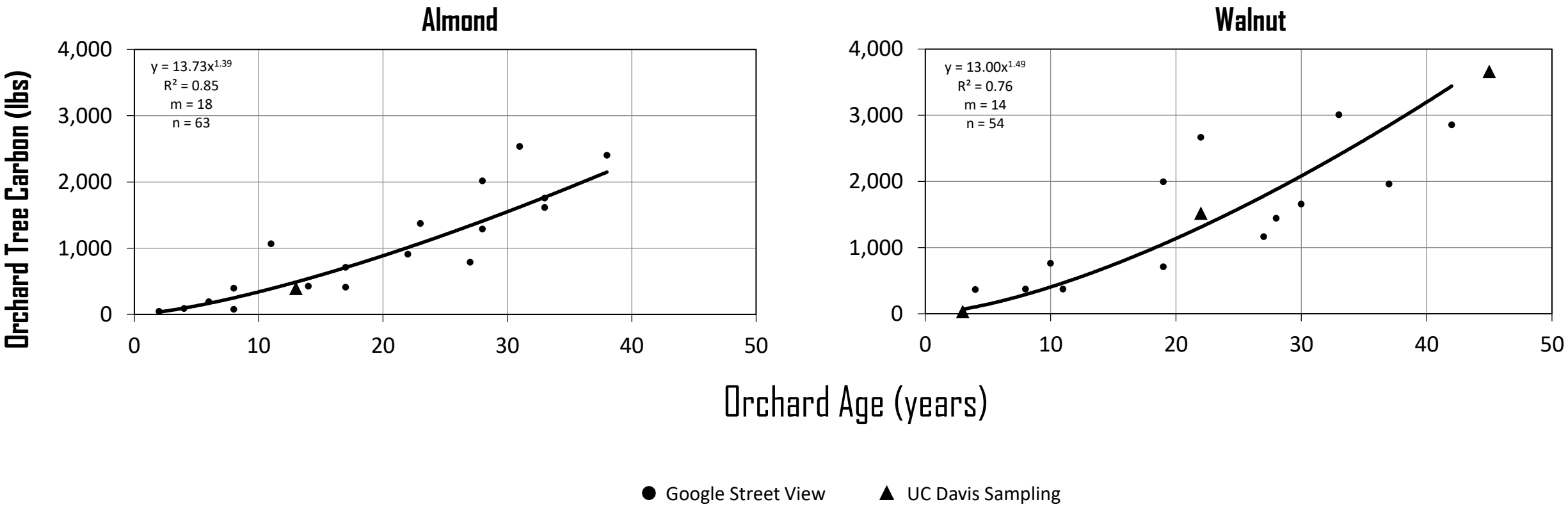
Orchard Carbon Quantification Methods



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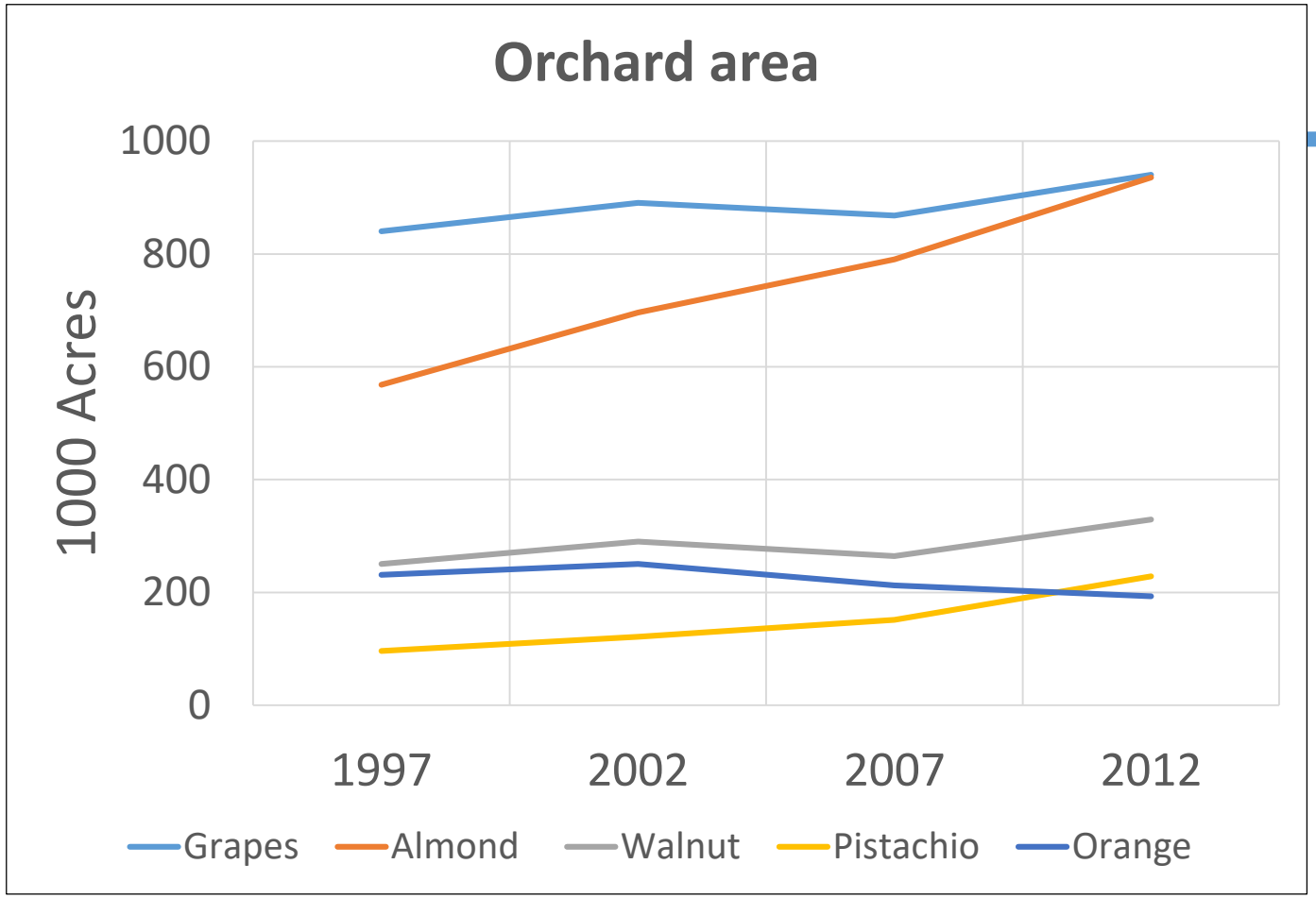
Orchard Carbon Quantification Methods

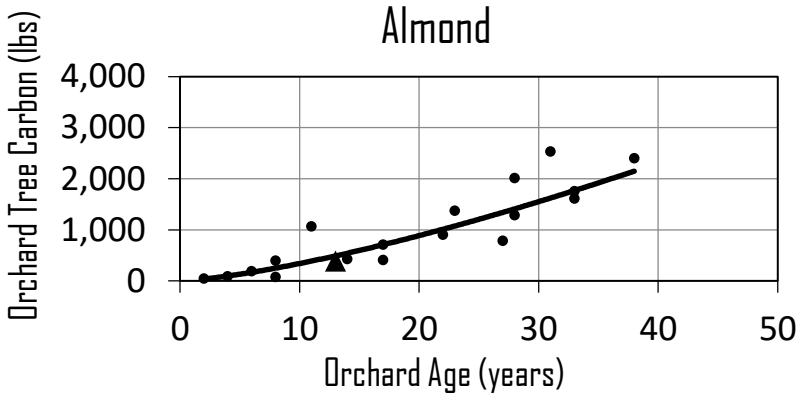
Map orchard types and ages	Relate height to age/orchard type	Relate height to diameter	Apply allometric equations	**Relate tree density to age**	Quantify Carbon Content

Orchard Carbon Quantification Methods

Above and belowground carbon storage for grapes, almond, walnut, pistachio and orange orchards in California from 1997-2012



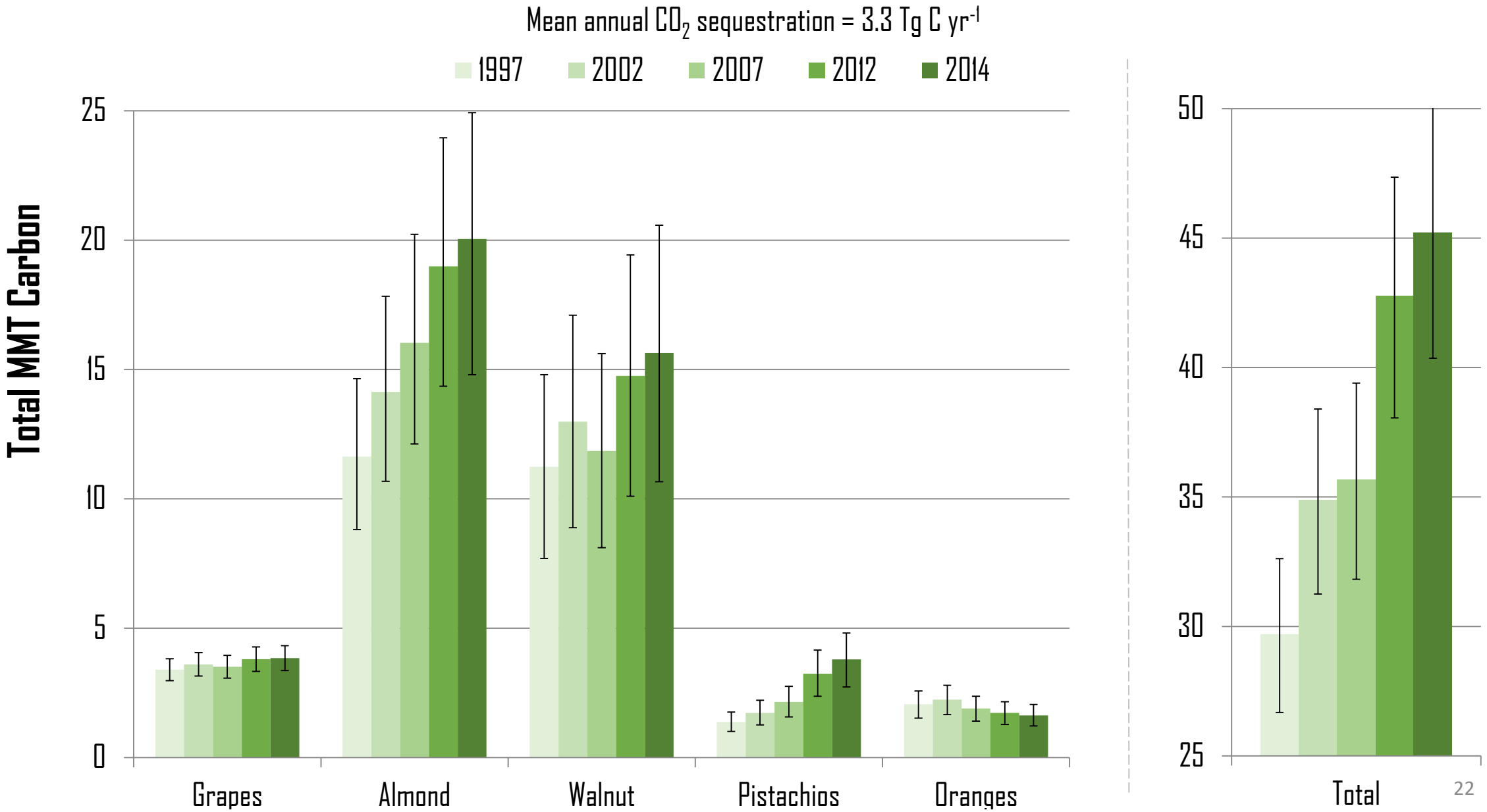
Age Distribution



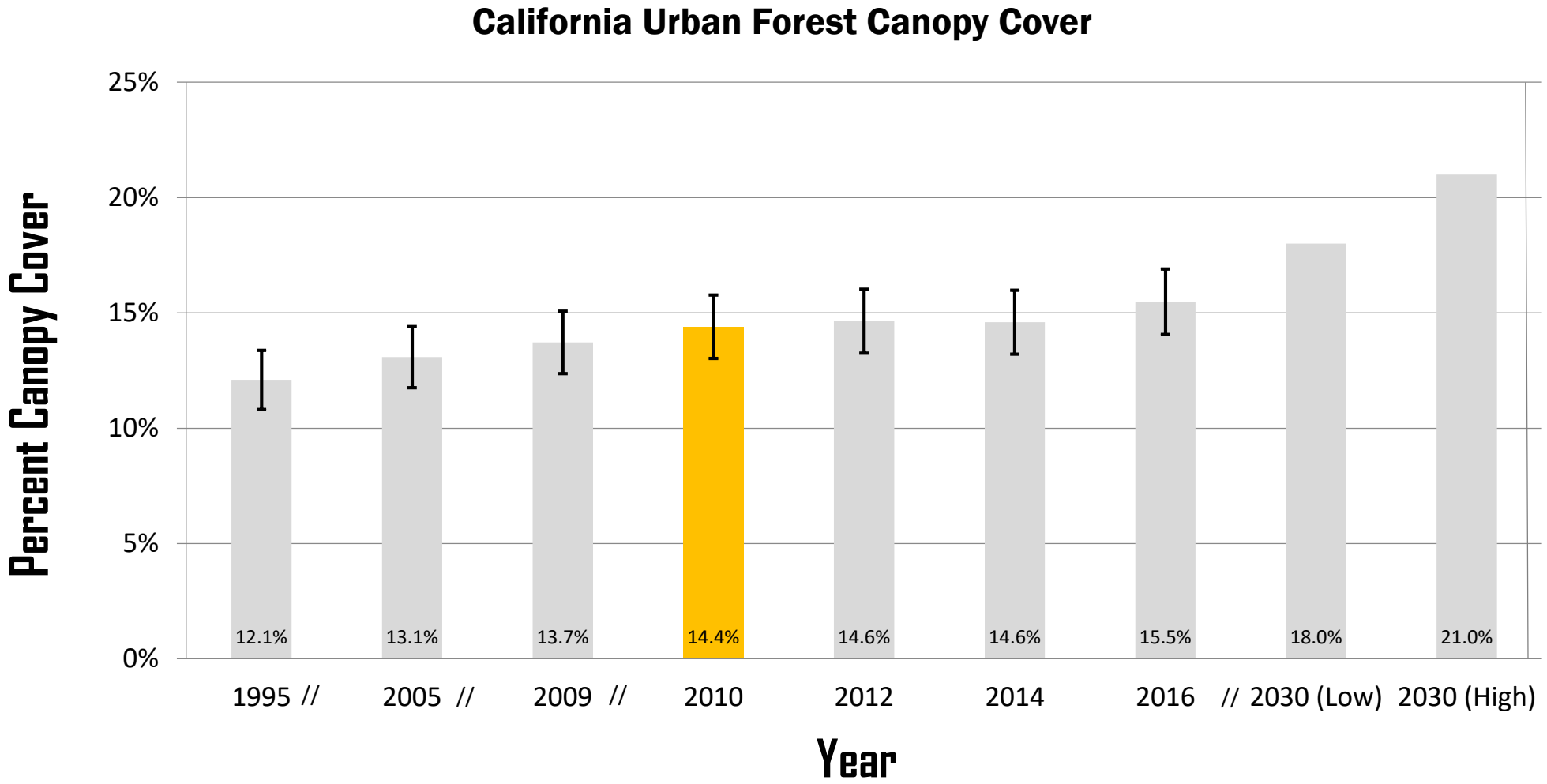
Carbon Content

Map orchard types and ages	Relate height to age/orchard type	Relate height to diameter	Apply allometric equations	Relate tree density to age	**Quantify Carbon Content**

Carbon Stocks Time-Series by Orchard Type



Urban Forest Carbon Quantification Methods



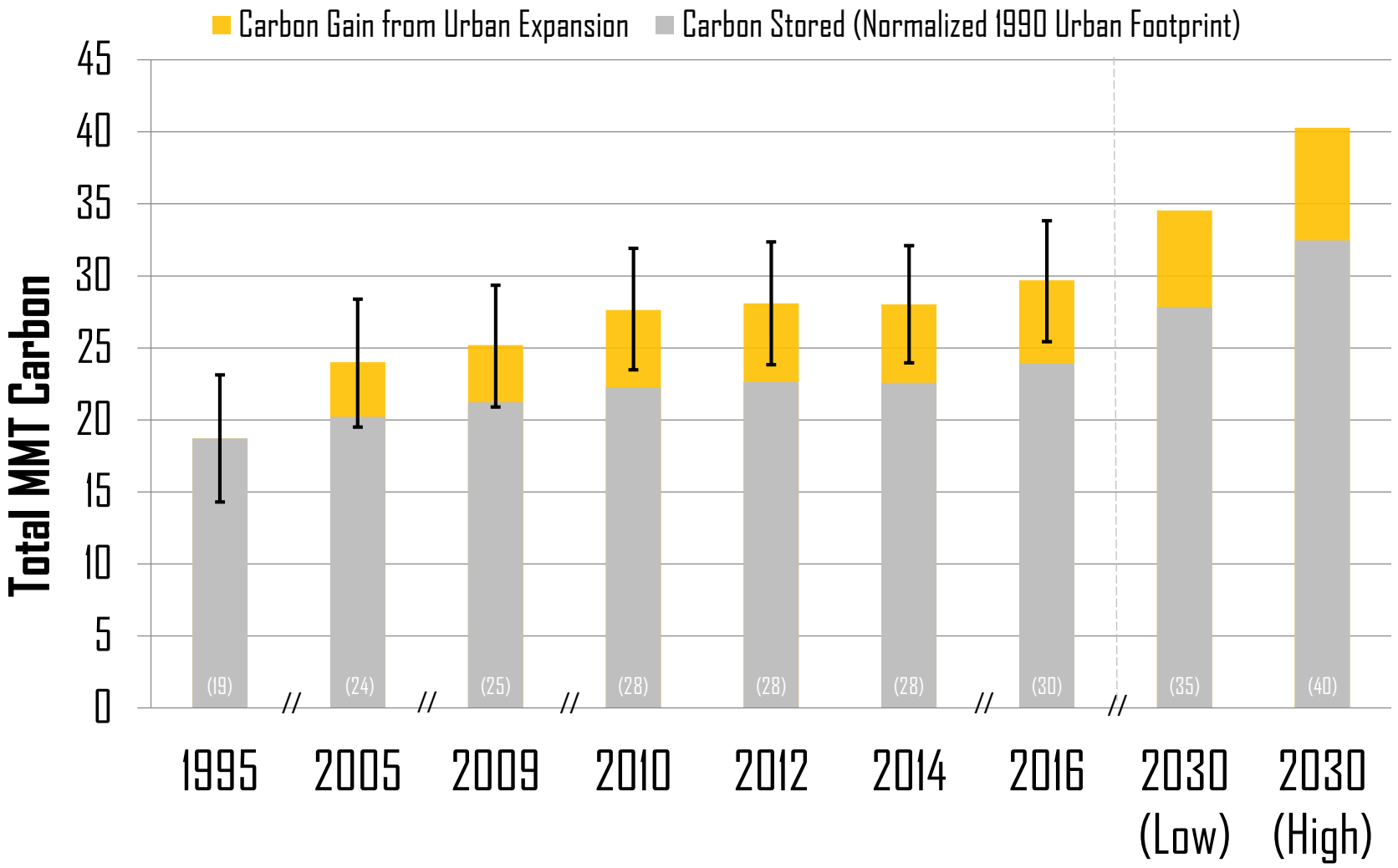
*Base year is highlighted in yellow

Bjorkman et al. 2015. (2015) Biomass, carbon sequestration and avoided emission: assessing the role of urban trees in California. Information Center for the Environment, UCDavis.

Urban Forest Carbon Quantification Methods

Adjust canopy cover from baseline	**Map canopy cover through time**	Calculate statewide carbon content

Urban Forest Carbon Quantification Methods



Mean observed annual CO_2 Sequestration

With urban Sprawl = 1.9 Tg C yr^{-1}
Without urban sprawl = 0.9 Tg C yr^{-1}

Adjust canopy cover from baseline	Map canopy cover through time	**Calculate statewide carbon content**

QUESTIONS?

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Soil Carbon & Wetlands Inventories

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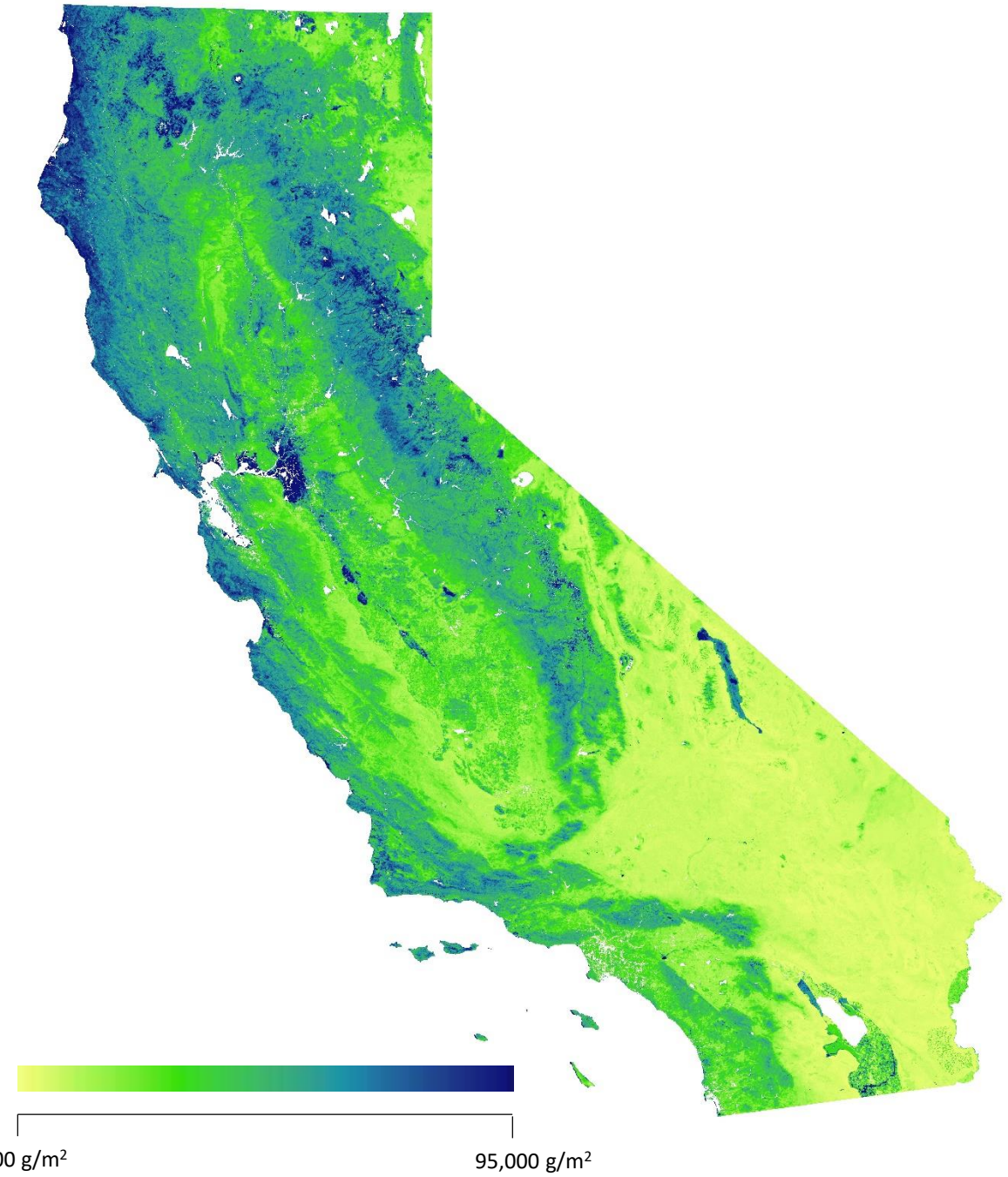


Analysis Overview

- **IPCC Tier 2 Methodology:**
  - Used to calculate soil organic carbon stock change on Forest Lands, Grasslands, Settlements, Other Lands, and Croplands in the Sacramento-San Joaquin Delta
  - Used SoilGrids for 2001 SOC stocks and LANDFIRE to determine land cover types and change
  - Created land cover change factors to track stock change due to conversion
- **IPCC Tier 3 Methodology:**
  - Used to calculate SOC stock and stock change on agricultural soils, exempting the Sacramento-San Joaquin Delta
  - Utilized the Denitrification Decomposition (DNDC) model and California specific activities data
  - Is disaggregated by county and crop type

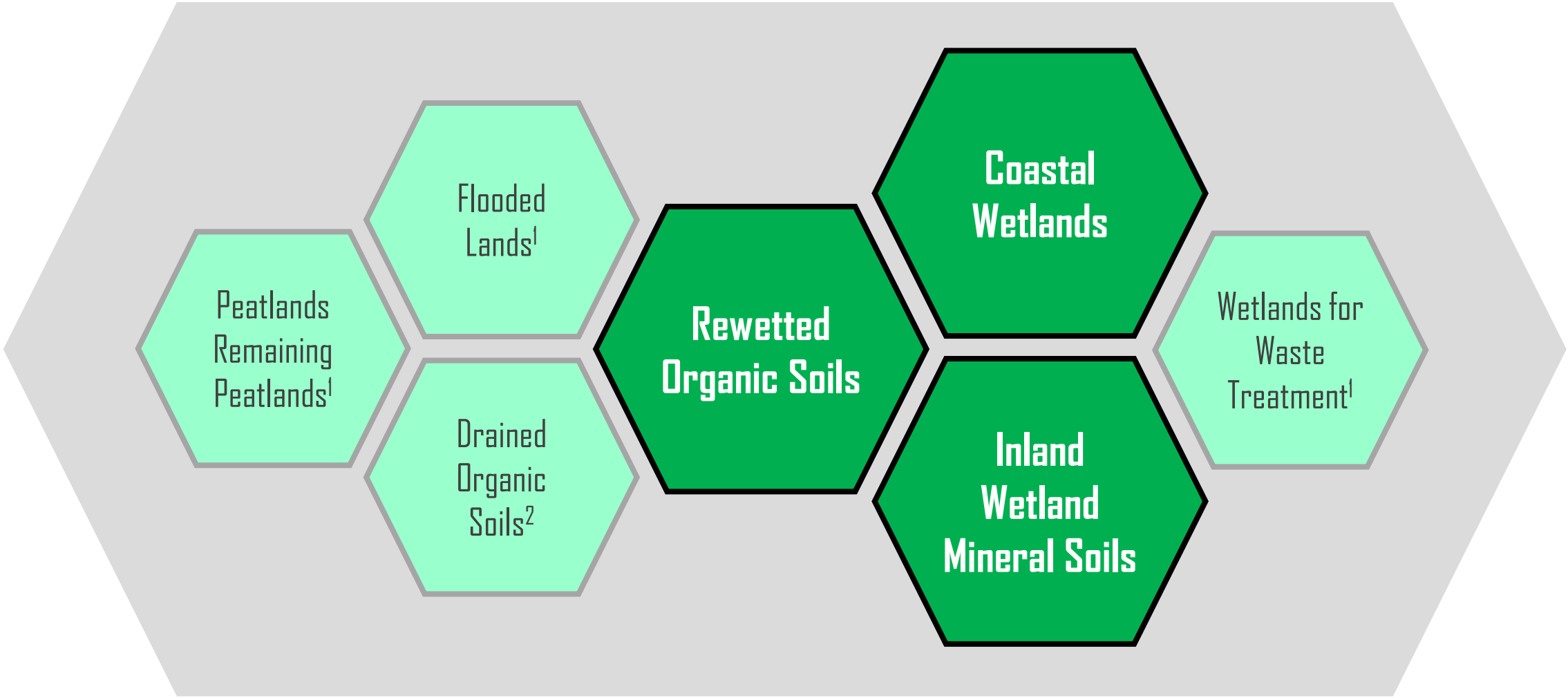
California Soil Carbon Stock Change 2001 – 2010 (MMT C)

		2010					
2001	Land Cover	Croplands	Forests	Grasslands	Other Lands	Settlements	Wetlands
	Croplands	**-14.18**	2.09×10^{-3}	8.42×10^{-5}	-0.12	-1.13	
	Forests	**-7.10**	-0.02	-1.56	**-6.98**	-0.09	-2.45×10^{-4}
	Grasslands	**-4.05**	3.89×10^{-3}	**-4.74**	-0.28	-0.08	
	Other Lands	-0.49	**12.59**	0.05	-1.63×10^{-3}	-1.15×10^{-3}	
	Settlements					-1.47	
	Wetlands	TBD					

Key Category Soil Carbon Stock Change 2001 - 2010

R. = Remaining | C. = Converted to

Wetlands by IPCC Category



[1] Does not exist in California or acreage is negligible

[2] Organic soils in the Delta have been drained for over 100 years, hence they are categorized as cropland on drained organic soil

Creating the Wetland Soils Inventory

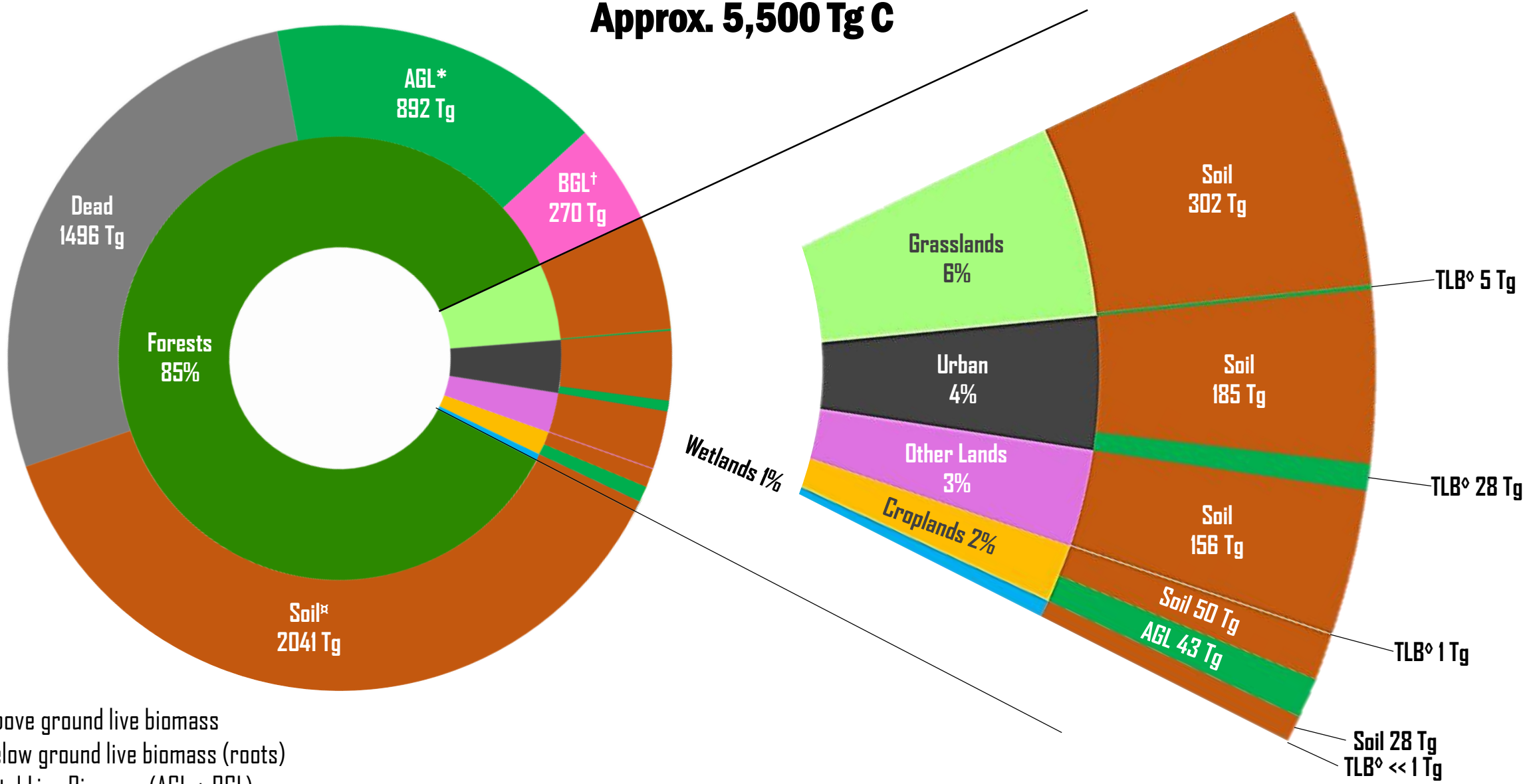
- **IPCC Tier 1 methodology**
  - Emissions = Area x Emission Factor
  - Emission factors provided by the 2013 Supplement to the 2006 Guidelines for National GHG Inventories: Wetlands
- Mapped the location and extent of wetlands using the California Aquatic Resources Inventory (CARI) product from the San Francisco Estuary Institute

2016 Wetland Emissions

Category	Emissions (MMT CO_2e)	Land Area (hectares)
Rewetted Organic Soils	-0.48	49,900
Coastal Wetlands	0.19	57,900
Inland Wetland Mineral Soils	-0.63	80,300
Total	**-0.93**	**188,100**

Quantified Statewide Carbon Stocks

Approx. 5,500 Tg C



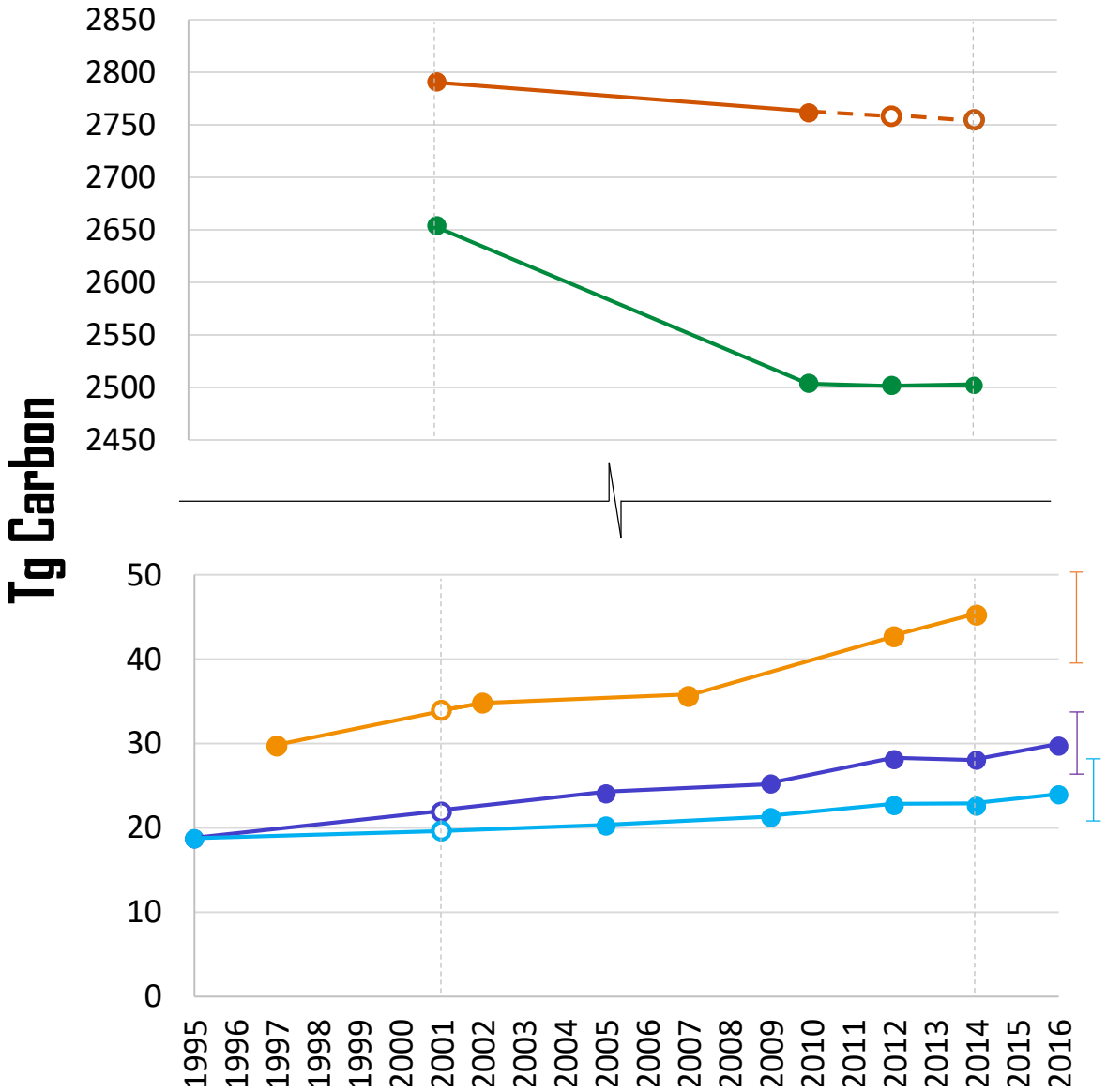
*AGL = Above ground live biomass

†BGL = Below ground live biomass (roots)

◊TLB = Total Live Biomass (AGL + BGL)

¤Soil carbon estimates are quantified to a depth of 30 cm pursuant to United Nations IPCC protocol

Statewide Carbon Stock Change by Land Cover Type



Soil Carbon
(to 30cm depth)
± 70%

Forests & Other Natural Lands
± 25%

Woody Crops

Urban Forest (incl. urban expansion since 1990)

Urban Forest (within the 1990 urban footprint)

Sum of Carbon Stocks (Tg C)		
2001	2014	13 Yr. Diff.
5,520	5,350	-3.1%
Annualized 13-year avg. change		-0.24%

QUESTIONS?

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Additional Analysis

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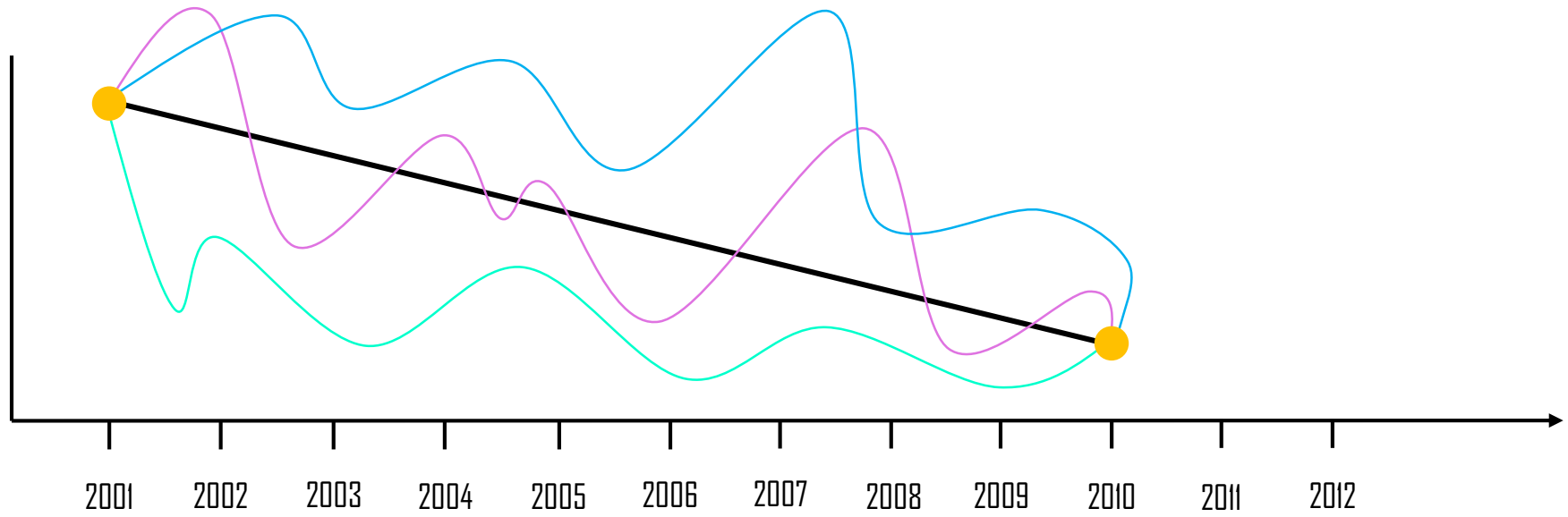
Senate Bill (SB) 859

- Complete a NWL Inventory
- Vision for framework that:
  - Supports GHG reduction goals and GGRF investments for forests;
  - Includes a framework for BAU projection; and
  - Considers state, regional, and project scales of accounting.
- Publish by December 30, 2018

Annualizing Inventory

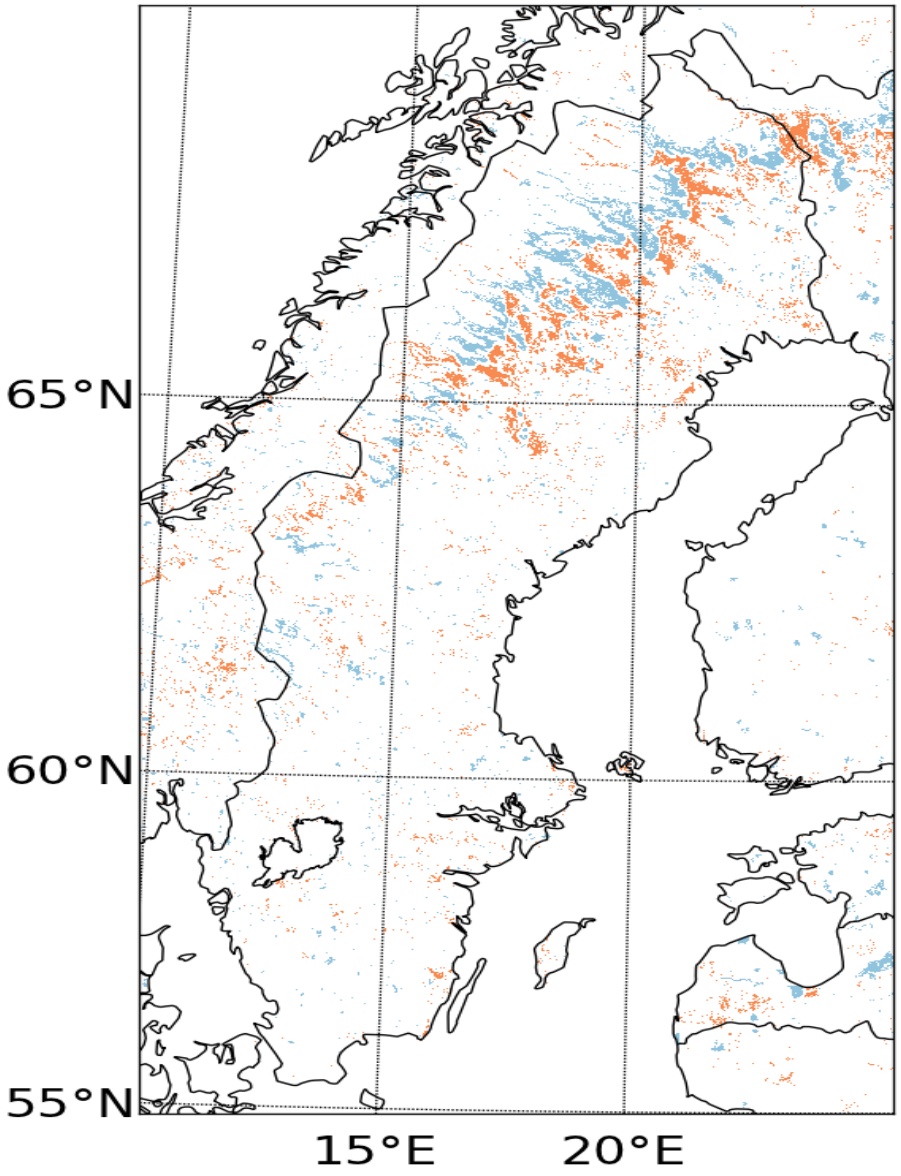
- Statistical model of growth with climate
- Annual observed disturbance satellite data
- Land use/land cover change included



NWL Visualization Tool

Monitoring at Multiple Scales

- Identify reference NWL very similar to project NWL
- Monitor progression of project and reference NWL through time
- Use large amounts of spatial & remotely sensed data
- Machine Learning
- Indicators must be remotely sensed
  - Growth
  - Disturbance



Example done in Sweden for conserved forests

Protected Forests

Actively Managed Forests

Long-Term Integrated Assessment

- Create a integrated landscape modeling system
  - Create a spatially explicit model that allows user-defined policy and environmental scenarios
  - Dynamically account for environmental and human system feedbacks
  - Dynamically model changes in species composition and succession
- Build internal capacity
- Ensure public transparency

Next Steps

1. Release the NWL inventory by end of year to meet SB 859
2. Continue to refine the inventory methods
   - Move the soil carbon inventory to Tier 3 methods
   - Develop the wetlands inventory for 2001 – 2010
   - Annualize the inventory
3. Disseminate data in a visualization tool
4. Assess the next generation modeling

Send comments to anny.huang@arb.ca.gov by November 14, 2018

Contacts:

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Anny Huang *Manager - Emission Inventory Analysis Section*	SB 859 Framework, NWL inventory & GHG inventory	Anny.Huang@arb.ca.gov
Klaus Scott *Technical Lead Staff*	Forests and other natural lands, wildfire	Klaus.Scott@arb.ca.gov
Megan Miranda	Soil carbon, emissions from fertilizer use, wetland, tracking land use change	Megan.Miranda@arb.ca.gov
Adam Moreno	Scenario projection modeling, cropland biomass, urban forest	Adam.Moreno@arb.ca.gov

QUESTIONS?

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